Length of 1st gill-cleft	12.0
Antero-posterior diameter of eye	2.9
Distance across head between eyes	10.2
Length of anterior border of pectoral	28.0
Height of dorsal	15.7
Anterior base of dorsal to anterior base of 2d dorsal	55.0
Anterior base of 2d dorsal to base of supracaudal	17.0
Length of supracaudal from dorsal pit	36.0
Length of infracaudal from ventral pit	27.0
Chord of caudal fin (tip to tip)	45.5
Greatest width of keeled peduncle	14.0

A portion of this shark's skin was tanned by the Ocean Leather Company, of New York, and it produced a high-grade, tough, pliable leather, capable of taking a pronounced gloss.

THE LARGE SHARKS OF CAPE LOOKOUT, NORTH CAROLINA. THE WHITE SHARK OR MANEATER, TIGER SHARK AND HAMMERHEAD.

RUSSELL J. COLES, DANVILLE, VA.

Plates 2 and 3.

In May, June and July, 1918, at Cape Lookout, North Carolina, I handled large numbers of sharks of many kinds for leather, food, oil and fertilizer, having established a shark-fishing station at that point now controlled by the Ocean Leather Company of New York, with which I am associated. The work was so intensive that it was impossible to make the scientific study of the material that I would have wished. It is perhaps true that sharks are well known in inverse ratio to their size, and my observations on those three species which attain the greatest dimensions are of greatest scientific interest.

Such notes as I was able to make I submitted to the Department of Ichthyology of The American Museum of Natural History, where Mr. John T. Nichols has given material aid in selection and arrangement of the matter contained in this article.

Carcharodon carcharias. White Shark. "Man-eater."

This species is so rare along the Atlantic Coast that when I captured a young specimen 6 ft. 2 in. in total length at Cape Lookout in May, I at once made careful measurements of it. It was a male but the claspers were only 1½ in. long. Shortly thereafter, about May 20th, I took a young female of the same species, and made measurements also of this specimen.

	Male	*Female*
Tip of nose to tip of tail	6 ft. 2 in.	7 ft. 3 in.
Tip of nose to origin of 1st dorsal	2 ft. 3 in.	2 ft. 10 in.
Origin 1st dorsal to origin 2d dorsal	1 ft. 11 in.	2 ft. 3 in.
Height 1st dorsal	7 in.	9 in.
Height 2d dorsal	1½ in.	1½ in.
Width 1st dorsal	8 in.	11 in.
Width 2d dorsal	1 in.	3 in.
Width of peduncle with keel	6 in.	7½ in.
Depth of peduncle	2 in.	2¼ in.
Width between upper and lower tail tips	1 ft. 8 in.	2 ft. 1 in.
Upper fork of tail, notch to tip	1 ft. 5 in.	1 ft. 1 in.
Lower fork of tail, notch to tip	1 ft. 2 in.	1 ft.
Length of pectoral	1 ft. 3 in.	1 ft. 5 in.
Width of pectoral	8½ in.	9½ in.
Girth	3 ft. 10 in.	4 ft. 3 in.
Tip of nose to mouth		6 in.
Tip of nose to eye		6 in.
Tip of nose to angle jaw		11 in.

Further notes on the female follow. Eye, large and dark in color. Belly clear white. Upper parts very dark blue-gray. A black spot on the upper surface of the pectoral with its front angle at the center of the base of the fin, outer angle extending towards the center of the fin, including the posterior lobe at the base of the fin and also extending onto the body. In color the flesh was distinct rich light pink salmon (I have never seen the flesh of any other shark so colored), except that extending along in the pink flesh on each side of the vertebral column from skull to just above vent there was an almost round strip of nearly black flesh. Both pink and black flesh were eaten and proved excellent. Usually the flesh of sharks is almost free of oil, but that of this fish was rich in oil, and its liver richest in oil of any that I

have seen. It was the very finest shark, or, in fact, fish of any kind that I have ever eaten, its flavor being quite similar to a big, fat white shad. I made an entire meal of man-eater shark, eating nearly two pounds for dinner.

A day later, the morning catch of 14 sharks included two more young man-eaters, both females, one 7 ft. 7 in. long, and one 7 ft. 3 in. long, and I made all measurements and observations to check and confirm absolutely my notes regarding the one taken on the previous day.

At the very time when the second young man-eater was captured, fishermen claim to have seen a very large shark, with similar lamnoid tail, as long as their 25-ft. launch, entangled in a nearby net. It fought very violently and they cut it loose. I did not give their report entire credence, allowing for possible exaggeration, until on June 28th I found a large white shark in a dying condition in one of the nets, which may well have been the same individual. Unfortunately it escaped in its death-struggle.

My carefully noted observations justify the following claim of dimensions for it: length, 22 ft.; head, larger than 50-gallon barrel; mouth, 3 ft. wide; circumference at arm-pit of pectoral, 18 ft.; length of pectoral, 6 ft.; width of pectoral, 3½ ft.; dorsal, not seen; width at caudal notch, origin of tail, 20 in.; width of tail, 7 ft.; weight, over 2 tons.

I consider it highly probable that this large shark was the mother of the young ones taken, and that she had given birth to them near Cape Lookout in May. These are points which make the presence of this species here still more interesting.

The white shark is a more general feeder than the hammerhead, but subsists largely upon fishes of its own catch, and in four small examples, which I have recently examined, the only recognizable material contained in their stomachs was *Cynocion regalis* (weakfish), and *Menticirrhus americanus* (whiting). As they reach greater age they show a disposition to

specialize on other food, which is often sea turtles. In my opinion few white sharks ever attack man or look on him as food, but a white shark having once done so, by chance, that individual immediately becomes very dangerous.

I hope I will be pardoned for introducing into a scientific paper of this nature my first two adventures with the white shark. In 1903, in the Bight of Cape Lookout, North Carolina, I was out in a very small skiff harpooning turtles, and armed with rifle, light harpoon, and heavy knife, when an 18-ft. shark, easily recognizable as this species, charged, halting only when in contact with my skiff, where, with its large staring eye watching my every move, it lay for some seconds almost motionless with part of its back exposed above the surface, while I crouched with finger on the trigger of the high-powered rifle, aimed in front of the first dorsal fin. The shark then began a series of rapid evolutions, turning several times on its back while circling the skiff, into which it splashed much water. It then retired to a distance approximating a hundred yards and then, turning, charged at great speed directly at the skiff, when suddenly in the line of its attack a large logger-head turtle came to the surface and was seized in the jaws of the shark, which I heard crushing through the shell of the turtle. I am convinced that this shark had satisfied himself that I was suitable for food and had only retired to acquire speed for leaping into the skiff and seizing me, and that the coming to the surface of the turtle at that instant was all that saved me from a dangerous, knife to shagreen fight.

My second adventure with the white shark occurred some years later, and although it contained an instant of close infighting, yet it was much less dangerous, for I was then trained and steadied by having won many knife fights with sharks and large rays. After trying for an hour to approach within harpooning distance of a large man-eater which was swimming in shallow water near the scene of my former

encounter, I got over-board in a depth of five feet of water and had the boat retire to a distance of a hundred yards with the coil of rope, which was attached to the harpoon which I had with me. I also took with me half a bushel of crushed and broken fish to attract the shark, which was then swimming on or near the surface, half a mile to leeward of me. Soon the shark could be seen zig-zagging its course toward me, by crossing and re-crossing the line of scent from the broken fish, just as the bird-dog follows up the scent of quail. With harpoon poised, I crouched low, trusting that its approach would be continued in this manner, until, by a long cast, I could fasten my harpoon in its side. The scent of the broken fish, however, was so strong that they were definitely located, and the shark charged from a hundred feet away with a speed which has to be seen to be appreciated. I met the onrushing shark by hurling my harpoon clear to the socket into it, near the angle of the jaw, and, as the iron entered its flesh, the shark leaped forward, catching me in the angle formed by its head and the harpoon handle, which caught me just under the right arm, bruising me badly, while my face and neck were somewhat lacerated by coming in contact with the rough hide of the side of its head. As my right arm was free, it was a great chance for using the heavy knife, with which I was armed, had my tackle been strong; but the force of the blow snapped the poorly-made harpoon at the socket and the shark escaped, although it carried its death wound. I never again employed the same black-smith to forge my harpoons, but that poorly-made iron surely brought to a sudden ending a most exciting situation.

Galeocerdo tigrinus. Tiger Shark.

This is an abundant and widely distributed shark, very easily identified by its big head and tapering body, spotted color, and unique teeth. It is doubtless due to its large size and the consequent difficulty

of handling specimens that it seems to be imperfectly described in current literature. In the figure in Nichols and Murphy, Long Island Sharks,[1] for instance, I find the dorsal fin placed too far forward, and the long peduncular keel, which is a characteristic feature of the species, has been quite generally overlooked. It is with much pleasure, therefore, that I publish a photograph which shows the characters of the fish very well, and also the measurements of two female specimens, one of 6 feet, taken May 27th, and one of 12½ feet, taken July 5th.

	Young	*Adult*
Tip of nose to tip of tail	6 ft.	12 ft. 6 in.
Across top of head from eye to eye	9 in.	1 ft. 9 in.
Tip of nose to origin 1st dorsal	1 ft. 8 in.	4 ft.
Origin 1st dorsal to origin 2d dorsal	1 ft. 10 in.	2 ft. 10 in.
Caudal notch to tip of tail	1 ft. 9 in.	2 ft. 9 in.
Caudal notch to bottom tip of tail		1 ft. 8 in.
Fork notch of tail to top tip of tail	1 ft. 5 in.	
Fork notch of tail to bottom tip of tail	5 in.	
Width at caudal notch	3½ in.	
Depth at caudal notch	2½ in.	
Side mackerel-like keel extending up the sides faintly as far as origin 2d dorsal		
Length pectoral	9½ in.	1 ft. 10 in.
Width pectoral	6 in.	1 ft. 4 in.
Width 1st dorsal	8½ in.	1 ft. 3 in.
1st dorsal, height	6½ in.	1 ft. 10 in.
2d dorsal, width	5½ in.	10 in.
2d dorsal, height	2 in.	5 in.
Girth (at origin 1st dorsal)	2 ft. 1 in.	5 ft. 8 in.

Further notes concerning the young shark follow. Eye, large, dark, staring, and near tip of nose. Blunt, wide head. Mouth wide and near tip of snout. Color white on belly, but dark on back and sides, with darker vertical tiger-like markings. Specimen very thin, with empty stomach. My personal test proved the flesh excellent for food.

Further notes concerning the adult shark follow. Side keels extending from caudal to gill slits, more pronounced near tail. Vertical stripes or tiger markings not so plainly marked as in young. Color of back very dark, belly white. Stomach con-

[1] Nichols, J. T., and Murphy, R. C., 1916. Long Island Fauna—IV, The Sharks, Brooklyn Museum Science Bull., Vol. 3, No. 1.

tained most varied assortment of food that I have ever found in any shark, consisting of parts of three very large stone crabs, one bird, the small diver called locally water witch, and other unidentified substances. Its liver was 7 ft. in length, and rich in oil, (actual yield, 15 gallons). Eye, the usual dark, staring eye of the man-eating sharks. I weigh 275 lbs. and have a 52 inch waist, yet I passed through its jaws, which I have nicely cleaned. This shark was not securely fastened in the net and was tearing its way out when I fastened it with a harpoon just in time, and a most savage fight followed. The parts of the tail stood more at an angle with the body than in the young, but the angle was not as pronounced as in the great white shark.

There can be little doubt that the tiger shark regularly preys on other sharks to a considerable extent. During the few weeks that I was watching the fishery at Cape Lookout I examined the stomachs of three young tiger sharks, and in all three I found cleanly bitten pieces of freshly eaten shark-meat with skin attached, just as if the chunk of meat had been cut from the side of a shark. In the largest example, 7 ft. 9 in. in length, caught in my nets June 25th, there were eleven of these chunks of shark meat of from 1 to 5 lbs. each in weight, and they represented *hammerhead, sharp-nosed* and *ground sharks.*

Additional observations made during first week of August on three more tiger sharks, each in excess of twelve feet in length, confirm my former observations as to the varied character of their food. In one of them I found a freshly-eaten logger-head turtle, approximating 100 lbs. in weight, which had been bitten through both shells, in three places and the pieces of shell much crushed, yet all parts of the turtle were present.

Probably tiger sharks will use as food, when hungry, any creature which they find moving in the water, for which reason they must be dangerous as man-eaters; but I do not regard them as nearly so danger-

ous as a white shark which has once acquired the habit of eating human flesh. While it is not fastidious, I have no evidence as yet that even the tiger shark will eat unclean food, and in my opinion, the sharks which eat garbage or putrid matter are exceptional individuals, which, through some accident, have acquired the habit.

Sphyrna zygaena. Hammerhead Shark.

One of the most interesting facts about the hammerhead shark is that some of the large females with non-functional uteri are abnormal in form and feeding habits. Below are presented detailed measurements of a normal large female for comparison with such an abnormal shark.

The former, 11 ft. 1 in. in total length (snout to tip of caudal), enmeshed in a net and dead when taken out, July 10th, had apparently been feeding exclusively on Spanish mackerel, as this was the only recognizable material in its stomach. I consider fish like the Spanish mackerel the normal food of the hammerhead shark.

The second, 13 ft. 10 in. long, was captured a week earlier. It is probable that within the previous two weeks this large shark had eaten from my nets more than 50 sharks of about 6 ft. in length, leaving only their heads gilled in the net; and, with at least half a dozen species to select from, it was always her own species which she selected. At the time of her capture she had just eaten four of her species from my net, two of which had been swallowed whole, except the head of 5 ft. examples, and there were four cleanly-cut pieces which represented entire bodies, except heads, of two more 6 ft. hammerhead sharks; then the stomach contained more than a peck of vertebrae of sharks, provisionally identified as her own species.

There is probably no fish as careful about its diet as the shark, and those that eat anything but freshly caught fish are the exception and not the rule.

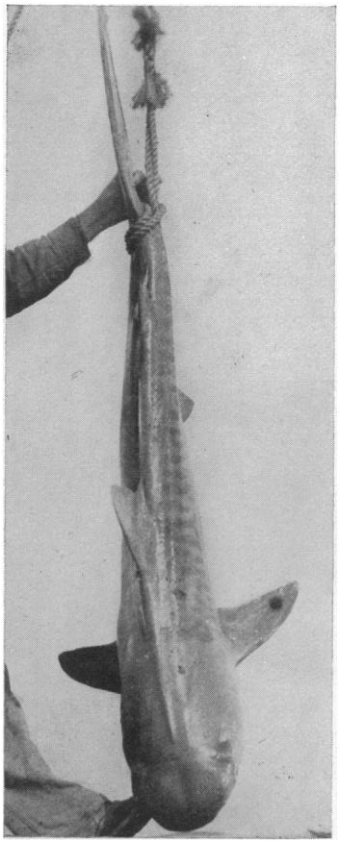
Some species even subsist almost exclusively upon only one species of fish, to such an extent that when a person is fishing for them with a hook baited with a perfectly good fresh fish, he may see a shark nose the baited hook repeatedly and leave it. I have had certain sharks repeatedly reject in this manner several species of fish and then eagerly take the hook when baited with the species of fish which is their habitual food. This is especially true of the hammerhead shark, which follows and subsists on the schools of Spanish mackerel, and of the very many which I have examined the stomachs of all but a small fraction contained, as far as I have identified, no other substance than Spanish mackerel. The exceptions were only very old examples, several of which had become solitary in habit and subsisted exclusively upon sting rays, which, as far as observed, were *Dasyatis*. Others, which were easily recognizable by their badly worn teeth, had become cannibalistic and confined their cannibalism to their own species.

I attribute this abnormal condition to great age. I have examined specimens over 14 ft. long, in every way normal and with functional uteri, which I do not consider so old.

I believe that certain examples of hammerhead shark of great age become cannibalistic, by evidence afforded by a number of examples, but I have no evidence that such is the case before their length exceeds 10 ft., and I have probably examined a thousand examples.

The present specimen of 13 ft. 10 in. illustrates the change of form accompanying this change of habit. This example is abnormal in point of stoutness, for, to have been normal with this circumference, length of fins and very great weight, the width of head should have exceeded 5 ft. and the length of body should have exceeded 16 ft. The mouth and teeth were also abnormally large for this short length.

The uteri of this specimen were small, malformed, almost obsolete, and non-functional. From



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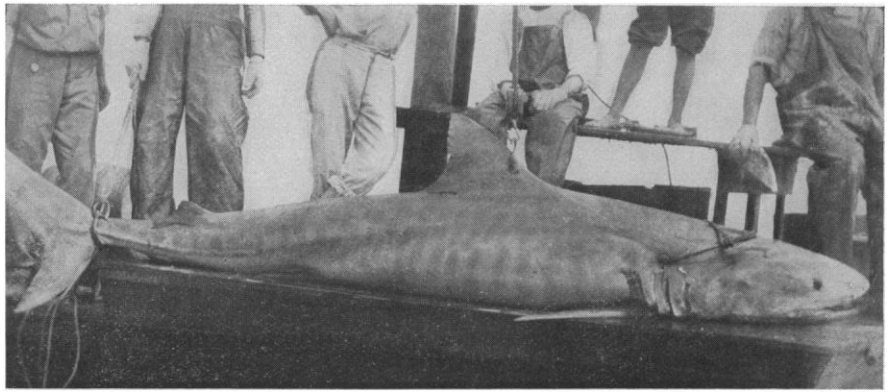

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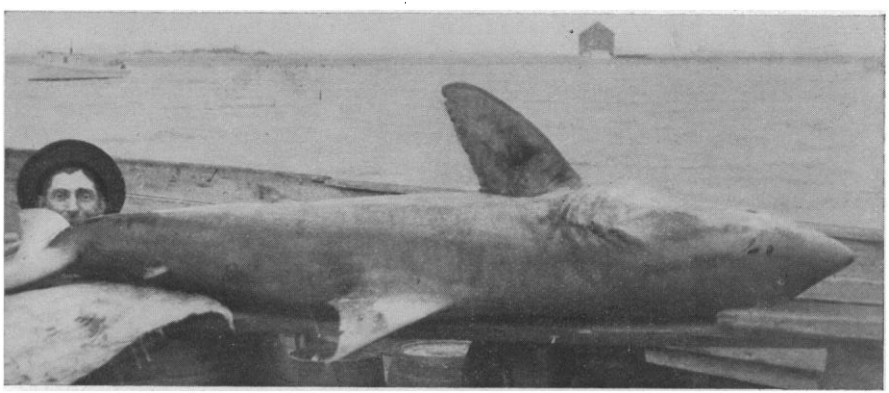

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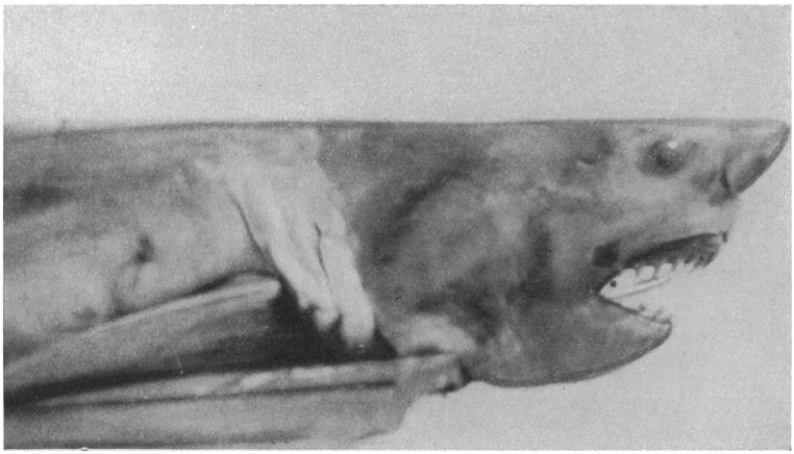
Fig. 1. *Galeocerdo tigrinus,* young. **Fig. 2.** *Galeocerdo tigrinus,* adult. **Fig. 3.** *Carcharodon carcharias,* young.



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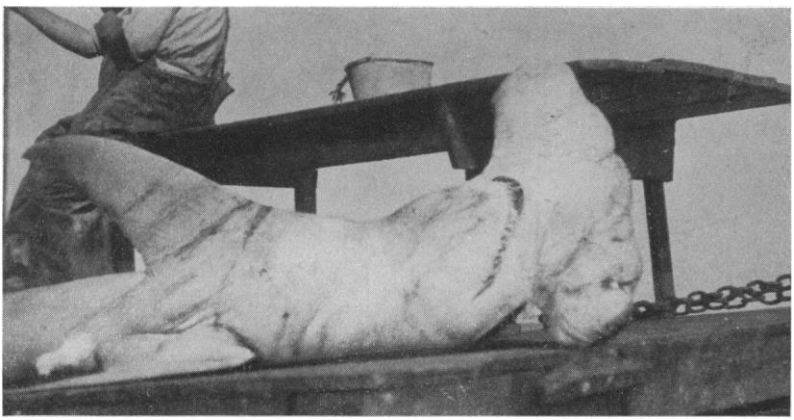

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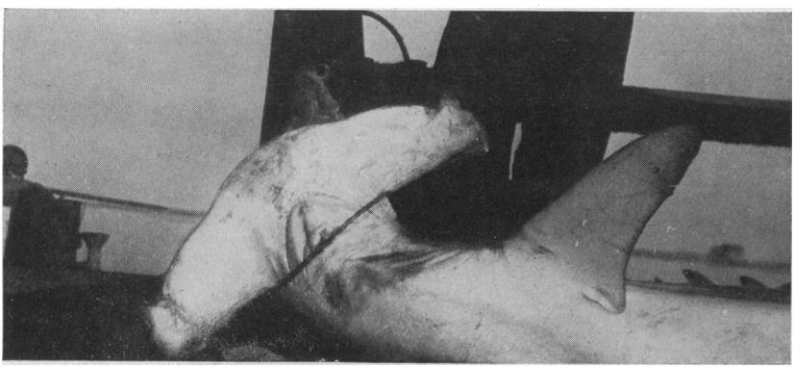

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Fig. 1. *Carcharodon carcharias*, young. Fig. 2. *Sphyrna zygaena*, adult ♀, abnormal.
Fig. 3. *Sphyrna zygaena*, adult ♀, normal.

evidence obtained by examination of the uteri of many very old female sharks, I am of the opinion that after they have reached very advanced age, their reproductive organs cease to be functional.

Hammerhead	No. 1 (Normal)	No. 2 (Abnormal)
Length	11 ft. 1 in.	13 ft. 10 in.
Tip of nose to origin 1st dorsal	3 ft. 2 in.	4 ft. 2 in.
Origin 1st dorsal to origin 2d dorsal	3 ft.	4 ft. 2 in.
Height of 1st dorsal	1 ft. 7 in.	2 ft. 7 in.
Width of 1st dorsal	1 ft. 5 in.	1 ft. 9 in.
Height of 2d dorsal		11 in.
Width of 2d dorsal		1 ft. 3 in.
Caudal notch to tip of tail	3 ft. 10 in.	
Length of pectoral	1 ft. 6 in.	2 ft.
Width of pectoral	11 in.	1 ft. 4 in.
Width of head,—eye to eye	2 ft. 8 in.	3 ft. 6 in.
Length of head,—side of neck to tip of nose	10 in.	
Width of head at spiracles		9 in.
Head, notch at tip of nose to mouth		8½ in.
Narrowest point of length near eye	6 in.	
Tip of nose to front of mouth	6½ in.	
Top fork of tail, from notch to tip		3 ft. 9 in.
Bottom fork of tail, from notch to tip		1 ft. 1 in.
Circumference at origin 1st dorsal	4 ft.	5 ft. 7 in.
" at neck	2 ft. 8 in.	4 ft. 1 in.
" at vent	2 ft. 8 in.	
" at caudal notch	1 ft. 4 in.	1 ft. 8 in.
" at base 2d dorsal		2 ft. 11 in.
Length of head from side of neck to front		10½ in.

I may further note in regard to the first of these two sharks that the front of its head was more crescentic in form than usual in the species, the notch in the center of the nose only faintly indicated, and that it contained at least 18 young, almost ready to be born. The smallest was 1 ft. 9¾ in. long, head 5¾ in. wide, the largest 2 ft. 2½ in. long, head 7 in. wide, average length 2 ft., width of head 6¼ in. Size of young in sharks depends on size of mother. I have often caught sharks of this species, long after their birth, measuring less than 20 inches, indicating a smaller mother, and I have found larger embryos not so far advanced in a larger example.